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*Indian Standard*

**IS 16722 : 2018**

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# Radio Frequency Identification (RFID) System for Automotive Applications — Specification

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Intelligent Transport Systems Sectional Committee, TED 28

## FOREWORD

This Indian Standard was adopted by the Bureau of Indian Standards, after the draft finalized by the Intelligent Transport Systems Sectional Committee had been approved by the Transport Engineering Division Council.

RFID uses electromagnetic fields to transfer data, for the purpose of automatically identifying and tracking tags attached to objects.

This document is formulated based on the following MoRTH Resolution:

Resolution No. H-25011/04-2011 P&P (Toll) (Vol. II) dated September 28, 2011 and amendment vide Resolution No. H-20511/04-2011 P&P (Toll) (Vol) dated September 19, 2013 & RFID Tag Data Specification for Electronic Toll Collection System (ETC), IHMCL document dated 14th October 2014.

In the formulation of this standard, considerable assistance has been derived from the following publications:

| | |
|---|---|
| AIS-004 (Part 3) | Automotive vehicles — Requirements for electromagnetic compatibility |
| IEC 18000-6 C | Information technology — Radio frequency identification for item management — Part 6: Parameters for air interface communications at 860 MHz to 960 MHz |
| ISO 16750-2 | Road vehicles — Environmental conditions and testing for electrical and electronic equipment — Part 2: Electrical loads |
| ISO 10605:2008 | Road vehicles — Test methods for electrical disturbances from electrostatic discharge |
| IS /IEC 60947-1:2004 | Low-voltage switchgear and control gear |
| IS/IEC 60529:2001 | Degrees of protection provided by enclosures (IP CODE) |

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 : 1960 'Rules for rounding off numerical values (*revised* )'. The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard.

*Indian Standard*

# RADIO FREQUENCY IDENTIFICATION (RFID) SYSTEM FOR AUTOMOTIVE APPLICATIONS — SPECIFICATION

## 1 SCOPE

This standard covers the general definitions and abbreviations which are common for RFID used in automotive applications and the different applications of RFID including Electronic Toll Collection (ETC), Parking Fee Collection (PFC), and Vehicle Identification, etc.

The standard highlights the basic architecture and test requirements of the Radio Frequency Identification (RFID) tags and transceivers for Electronic Toll Collection 'ETC' application.

## 2 REFERENCES

The following standards contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

| *IS No.* | *Title* |
|---|---|
| 9000 | Basic environmental testing procedures for electronic and electrical items |
| (Part 2) | Cold test |
| (Part 3) | Dry heat test |
| (Part 5) | Damp heat (Cyclic) test |
| 10250 | Severities for environmental test for automotive electrical equipment |

## 3 DEFINITIONS AND TERMINOLOGY

For the purpose of this standard, the following terms and definitions shall apply.

**3.1 Tag, Transponder** — Device that responds to an interrogation signal from a transceiver.

**3.2 RFID Tag** — A label which uses radio frequency transmission to identify a specific Code/Tag ID. RFID tags are of two types; Active Tag, Semi Passive tag and Passive tag.

**3.3 Active Tag** — A tag that possesses an on-board battery and periodically transmits its ID signal.

**3.4 Passive Tag** — The type of RFID Tag which does not require any internal power source. It uses the transceiver's signal to cause a response from the tag.

**3.5 Semi Passive Tag** — The type of RFID Tag that operates similarly to the passive tag, using the reader signal to cause a response from the tag. However it has on-board power for powering electronics used in conjunction with off-board sensors (for example. a thermal sensor)

**3.6 Tag ID** — The unique electronic identification programmed into the Integrated circuit of the RFID Tag during manufacture.

**3.7 Printed Antenna** — Those antennas which are printed in the substrate using electrically conducting ink.

**3.8 Etched Antenna** — Those antennas which are manufactured using thin metallic foil which are conducting in nature (copper, aluminium, etc) adhered to a plastic substrate.

**3.9 Transceiver** — A device that can both transmit and receive communication signal. It has both transmitter and receiver.

**3.10 RFID System** — The RFID system includes both transceiver and tag.

**3.11 Ratings** — The voltage and current range at which the active RFID tag is designed to operate satisfactorily.

**3.12 Rated Voltage** — The operating voltage (12/24 V) specified by the manufacturer for terminal or pair of terminals at which the RFID is designed to operate satisfactorily.

**3.13 Type Tests** — Tests carried out to prove conformity of RFID with respect to the requirements of this standard. These are intended to prove the general quality, design and performance of a given type of RFID.

**3.14 Acceptance Tests** — Tests required to be carried out on samples taken from a lot for the purpose of acceptance of the lot.

**3.15 Lot** — Fifty numbers of RFIDs of the same type, design, rating, manufactured in the same premises, using the same process and materials, offered for inspection at a time shall constitute a lot.

### 3.16 Abbreviated Terms

a) DUT — Device under test.

b) EPC — Means electronic product code which is a unique identification code for electronic products.

c) ETC — Electronic toll collection.

d) ID — Identification.

e) RFID — Radio frequency identification.

f) UHF — Ultra high frequency.

### 3.17 Criteria as Defined in IEC 61000-4-2:2008

a) *Criterion A* — Normal performance within limits specified by the manufacturer;

b) *Criterion B* — Temporary loss of function or degradation of performance which ceases after the disturbance ceases, and from which the equipment under test recovers its normal performance, without operator intervention;

c) *Criterion C* — Temporary loss of function or degradation of performance, the correction of which requires operator intervention; and

d) *Criterion D* — Loss of function or degradation of performance which is not recoverable, owing to damage to hardware or software, or loss of data.

## 4 SPECIFICATION FOR RFID TAG

### 4.1 Power

The tags in ETC application are passive.

### 4.2 Frequency

UHF 865 MHz to 868 MHz or as defined by WPC from time to time

### 4.3 Data Transfer Rate

The data transfer rate should be min 512 kbps under ideal conditions and 64 to 512 kbps under field conditions.

### 4.4 Protocol

The protocol to be used is EPC Gen 2 V2, ISO 18000-6C or as per the latest amendment to this standard.

### 4.5 Dimensions (Including the Substrate/Backing)

Maximum area occupied on the windshield shall be 50 cm$^2$.

### 4.6 Physical Printing of Tag ID on the Tag

The Tag ID / EPC shall be physically printed on the tag using the hexadecimal numbering and bar code/ QR Code system and shall be adequately clear for easy visual recognition.

### 4.7 TAG Position and Orientation

Tag should be pasted on the top centre or top left of the wind screen. Tags should not be pasted on the film or dark area on top of the windshield. Tags should be pasted with horizontal orientation of antenna.

### 4.8 Tamper Proof RFID Label

The Tag shall be tamper proof label specially designed for tagging directly on windshield of an automobile. Any attempt to rip or tamper the label should result in disabling the entire functionality of the tags to ensure a unique one to one relationship between the tag and the vehicle thereby preventing unauthorized tag removal and transfer. Such features of RFID tag shall result in following actions:

a) Destroy or damage the antenna, and

b) Break the chip-antenna connection.

### 4.9 Memory

The minimum TID memory size should be 96 bits, minimum EPC memory size should be 96 bits and minimum User memory should be 512 bits.

### 4.10 Range

It should be possible to read the tags in a range of 4 m to 8 m.

### 4.11 Inter-operability

The tags should possess interoperability, that is, a tag of a particular manufacturer should be compatible with the transceivers of another manufacturer.

### 4.12 Tag Antenna

a) The tag antenna polarization shall be circular, and

b) The tag antenna shall be printed or etched.

### 4.13 Data Retention and Data Security

The data retention capability should be minimum 10 years. For data security the following features must be included: Lock, Unlock, Kill, Write protection, Password protection.

### 4.14 Tag Architecture and Contents

| *Header* | *EPC Manager Number* | *Asset Reference* |
|---|---|---|
| Determines type, length, structure and version of the EPC | Entity responsible for maintaining the EPC number | Identifies the vehicle |

The Data Structure of GIAI — 96 coding scheme as illustrated below:

| Coding Scheme | GIAI – 96 | | | | |
|---|---|---|---|---|---|
| Total Bits | 96 | | | | |
| Logical Segment | EPC Header | Filter | Partition | GSI Company Prefix | Individual Asset Reference Vehicle (ID) |
| Logical Segment Bit Count | 8 | 3 | 3 | 20-40 | 62-42 |
| Coding Segment | EPC Header | Filter | GIAI | | |
| Coding Segment Bit Count | 8 | 3 | 85 | | |
| Coding Method | 00110100 | Integer | As defined in the tag data standards | | |

| 8004 | | | 8907272 | 1 | 1 | 1234567892 | 00 | 0009 |
|---|---|---|---|---|---|---|---|---|
| Header | Filter | Partition | IHMCL Prefix | CCH ID | Tag Vendor ID | Vehicle ID | Future Use | Check Sum |
| 8 bits | 3 bits | 3 bits | 24 bits | 5 bits | 5 bits | 26 bits | 6 bits | 16 bits |
| 00110100 | 000 | 5 (decimal) | 8907272 | 1 | 1 | 1234567892 | 00 | 9 |
| Fixed | Fixed | Fixed | Fixed | Variable | Variable | Variable | Fixed | Variable |
| Total 38 bits | | | | Total 58 bits | | | | |

| **Bit Structure: 58 bits** | | |
|---|---|---|
| **Segment** | **Bits** | **Remarks** |
| Service Provider | 5 | Up to 31 service provider/ Issuers |
| Tag Vendor | 5 | Up to 31 Tag supplier |
| Unique Serial | 26 | Up to 6.7 crore unique ID's per service provider, per tag vendor |
| Future Usage | 6 | Any future application/ bifurcation, if needed |
| Check sum | 16 | For checking the validity of EPC encoding |

Each tag shall have a non-changeable and unique TID. This must be read by the transceiver at the point-of-sale and thereafter.

### 4.15 Classification of Tests

**4.15.1** *Criteria for Approval*

Minimum ten samples of RFID tags shall be submitted for testing together with the relevant documents. The testing authority shall issue a type approval certificate, if the RFID is found to comply with the requirements of the tests given in **4.15**.

In case of failure in one or more type tests, the testing authority may call for fresh samples not exceeding twice the number of original samples and subject them to test(s) in which failure occurred. If, in repeated test(s) no failure occurs, the test may be considered to have been satisfactory.

Curing time for the tag will be 15 min for test mentioned **4.15.2** to **4.15.6** and 24 h for the rest of the tests unless mentioned specifically in the test.

**4.15.2** *Visual Examination*

The maximum dimension will be checked for 50 cm$^2$ with no tolerance. Printing of the hexadecimal TID should be easily visible.

**4.15.3** *Functional Test*

The tag would be read/ tested with a transceiver for the functional usage and the TID will be noted for further tests.

**4.15.4** *Range Test*

The tags will be tested by an approved transceiver inside an anechoic chamber for a distance of 8 m. Functional test will be conducted at this range.

**4.15.5** *Interoperability Test*

The tag would be functionally tested with one or more than one approved fixed transceivers and one or more than one handheld transceivers for interoperability.

**4.15.6** *Speed Test*

The tag would be functionally tested with an approved reader at a speed of minimum speed of 20kmph to maximum speed of 80 kmph.

**4.15.7** *Electrostatic Discharge Test*

The system shall be subjected to tests as per ISO 10605. The maximum test signal severity levels shall be ± 3 kV at unpowered mode.

**4.15.8** *Endurance Test*

The RFID tag and transceiver shall be suitably mounted at an ambient temperature. The position of tag and transceiver would be fixed appropriately. A shutter arrangement would be made so that the shutter moves back and forth between the line of vision of tag and transceiver. The shutter shall be operated for 100 000 cycles. The transceiver should read the tag properly.

**4.15.9** *Vibration Test*

The test specimen (TAGS) mounted on a wind shield glass shall be rigidly fixed on a suitable vibrating machine constructed to produce simple harmonic function (a total amplitude of 1.5 mm) and shall be subjected to vibration through a frequency range of 10-55-10 Hz in a sweep period of 1 min with continuously varying frequencies. The vibration shall be applied for not less than 1 h in the directions of each of the 3 major axes of the light.

The tag after vibration test shall meet the requirements of visual examination and functional test.

**4.15.10** *Damp Heat Test*

The RFID should be tested according to IS 9000 (Part 5/Sec 2). The test is carried out at +25° to +55° C, humidity 95 percent. 6 cycles (each test cycle of 24 h) should be run with the system in off condition.

The functional test will be conducted on the TAG at start of 2nd, 4th, 6th cycle and after the test.

**4.15.11** *Ingress Test*

The ingress test shall be carried out in accordance with IS /IEC 60947-1 in conjunction with IS/IEC 60529 for IP 54 compliance.

The functional test will be conducted on the TAG before, during and after the test.

**4.15.12** *Corrosion Resistance Test*

The System should be tested according to **4.8** of IS 10250 for 96 h.

The functional test will be conducted on the TAG before, during and after the test.

**4.15.13** *Operating Temperature Test*

The sample tags (3 numbers) shall be pasted on a piece of vehicle windshield glass and shall be placed in cyclic chamber and subjected to operating temperature test as per specifications mentioned below:

| *Sl No.* | *Parameters* | *Specifications* |
|---|---|---|
| i) | Temperature | +80°C and –20°C |
| ii) | Duration | 16 h at each temperature |
| iii) | No. of cycles | 1 |

The tag after the test shall meet the requirements of visual examination and functional test.

NOTE — The operating temperature test shall be in accordance with IS 9000 (Part 2) and IS 9000 (Part 3).

**4.15.14** *Storage Temperature Test*

The system shall be placed in cyclic chamber and subjected to storage temperature test as per specifications mentioned below:

| *Sl No.* | *Parameters* | *Specifications* |
|---|---|---|
| i) | Temperature | +100°C and –40°C |
| ii) | Duration | 16 h at each temperature |
| iii) | No. of cycles | 1 |

The tag after the test shall meet the requirements of visual examination and functional test.

NOTE — The storage temperature test shall be in accordance with IS 9000 (Part 2) and IS 9000 (Part 3).

**4.15.15** *UV Radiation Test*

The system shall be exposed to radiation from a source having a spectral energy distribution similar to that of a black body at a temperature between 5 500 K and 6 000 K. Appropriate filters shall be placed between the source and the samples so as to reduce as far as possible radiations with wave lengths smaller than 295 nm and greater than 2 500 nm. The samples shall be exposed to an energetic illumination of 1 200 W/m$^2$ ± 200 W/m$^2$ for a period such that the luminous energy that they receive is equal to 4 500 MJ/m$^2$ ± 200 MJ/m$^2$. Within the enclosure, the temperature measured on the black panel placed on a level with the samples shall be 50 ± 5°C. In order to ensure a regular exposure, the samples shall revolve around the source of radiation at a speed between 1 and 5 litre/min. The samples shall be sprayed with distilled water of conductivity lower than 1 mS/m at a temperature of 23 ± 5°C, in accordance with the following cycle:

Spraying: 5 min; drying: 25 min.

The tag after the test shall meet the requirements of visual examination and functional test.

**4.15.16** *Peel Strength Test*

The dimensions for the test specimen shall be 25 mm wide and 300 mm length approximately.

A strip of tape is applied to standard test panel or other surface of interest with controlled pressure. Curing time for the tag will be 72h. The tape is peeled from the panel at 180° angle at a 200 mm/min rate, during which time the force required to effect peel is measured.

Acceptance criteria is as per the specifications below:

| *Sl No.* | *Property* | *Requirement* |
|---|---|---|
| i) | Peel strength initial after 20 min at room temperature | Minimum 800 g/2.5 cm |
| ii) | Peel strength after 48 h at room temperature | Minimum 1200 g/2.5 cm |
| iii) | Peel strength after environmental test | Minimum 1200 g/2.5 cm |

NOTE — *See* ASTM D 3330.

**4.15.17** *Acceptance Tests for tags*

The following shall constitute acceptance tests for tags after every 6 months or 100 000 samples, whichever achieved later:

a) Visual examination,
b) Functional test,
c) Peel strength test, and
d) Interoperability.

## 5 TRANSCEIVERS (READ/WRITE UNIT)

### 5.1 Fixed Transceivers

**5.1.1** *Transmission Frequency*

The operating frequency range should be between 865 and 868 MHz.

**5.1.2** *Communication*

Ethernet / Serial Communication (EIA Standard RS 232 C / RS 485).

**5.1.3** *RF Power Maximum*

1 W — transmitted/conducted and 4 W — EIRP (Equivalent Isotropically Radiated power) as per WPC norms.

**5.1.4** *Range*

The transceiver should be able to read the tag within the range of 4 m to 8 m. Test to be conducted inside an anechoic chamber.

**5.1.5** *Protocol*

The protocol to be used is EPC Gen 2, ISO 18000-6C/3.

**5.1.6** *Data Transmission Rate*

The data transfer rate of the tags should be minimum 100 kbps.

**5.1.7** *Polarization*

The polarization can be circular or linear, based on individual toll plaza designs, distance between 2 lanes, reader, tag mountings.

**5.1.8** *Crosstalk*

The communication should be limited to a transceiver and a tag.

**5.1.9** *External Antenna Ports*

The system should have a minimum 1 internal/external antenna.

### 5.2 Handheld Transceivers

The handheld RFID reader should be a single integrated module including handheld unit and RFID module.

**5.2.1** *Readability/ Writability*

The handheld wireless readers should be able to read the tag within a range of 0.5 m and 2 m.

**5.2.2** *Memory*

A non-volatile memory of minimum 512 MB.

**5.2.3** *Communication*

Communication can be done by using either of the technologies: Wireless, Bluetooth, USB, RS232 or Ethernet, etc.

**5.2.4** *Display*

Visual indication should be present.

**5.2.5** *Power Supply*

The power supply should be a Li-ion battery with a minimum 4 h back up with transmitter 'ON' and 24 h standby mode.

### 5.3 ETC POS Reader

The ETC POS reader should be a single integrated module including antenna and RFID module.

**5.3.1** *Transmission Frequency*

The operating frequency range should be between 865 and 868 MHz.

**5.3.2** *Readability/ Writability*

The handheld wireless readers should be able to read the tag within a range of 0 to 6 inch.

**5.3.3** *Memory*

A non-volatile memory of minimum 512 MB.

**5.3.4** *Communication*

Communication can be done using wireless, bluetooth, USB, RS232 or Ethernet, etc.

3M: GSM/GPRS, USB.

**5.3.5** *Display*

Visual Indication should be present.

**5.3.6** *Power Supply*

The power supply should be a Li-ion battery with a minimum 4 h back up with transmitter 'ON' and 24 h standby mode.

## 6 TESTS TO BE DONE ON TRANSCEIVERS (READ / WRITE UNIT)

The following shall constitute type tests.

### 6.1 Criteria for Approval

Minimum three samples of the transceivers shall be submitted for testing together with the relevant documents. The testing authority shall issue a type approval certificate if the transceiver is found to comply with the requirements of the tests given in **6**.

In case of failure in one or more type tests, the testing authority may call for fresh samples not exceeding twice the number of original samples and subject them to test(s) in which failure occurred. If, in repeated test(s) no failure occurs, the test may be considered to have been satisfactory.

### 6.2 Visual Examination

The system shall have a smooth finish and shall be properly assembled. It shall not contain any sharp edges, which may cause injury to the persons handling the system.

### 6.3 Interoperability Test

The transceivers would be tested with minimum three approved tags for interoperability.

### 6.4 Performance Test

Transceiver shall be connected in a suitable circuit and tested at nine points: Three voltage points (rated voltage ± 25 percent) and three temperature points (-25ºC, room temperature and +85ºC). At each test point the system shall be powered on and shut down 5 times as per the supplier's designated procedure. Minimum dwell time before start of test at each temperature is 1 h. The test will be conducted for at least 0.5 h after the temperature has stabilized.

After performance test, the transceiver shall meet the requirements of interoperability test (*see* **6.3**) with all components working at the end of the test.

The insulation resistance shall be not less than 1 MΩ.

### 6.5 EMI/EMC Test

The DUT shall be subjected to following tests:

a) Measurement of radiated electromagnetic emissions from the system according to CISPR 22 [*see* IS 6874 (Part 7)].

b) Method(s) of testing for immunity of the system to electromagnetic radiation according to IEC 61000-4-3 [*see* IS 14700 (Part 4/ Sec 3) : 2008] up to 1 000 MHz with 10V/m severity level.

No deviation in DUT functionality shall be observed during this test. DUT shall meet criterion A.

### 6.6 Electrostatic Discharge Test

The system shall be subjected to tests as per IEC 61000-4-2. The suggested intermediate severity levels are ± 3 kV. The minimum and maximum test signal severity levels shall be as per the table mentioned below:

| *Sl No.* | *Type of Tests* | | *Test Level, kV* | |
|---|---|---|---|---|
| | | | Minimum | Maximum |
| i) | Powered Condition | a) Direct contact discharge | ± 4 | ± 8 |
| | | b) Direct air discharge | ± 4 | ± 8 |
| | | c) Direct air discharge | ± 8 | ± 15 |

The system shall meet the functional status of criterion B during and after the discharge.

### 6.7 Vibration Test

The test specimen shall be rigidly fixed on a suitable vibrating machine constructed to produce simple harmonic function (a total amplitude of 1.5 mm) and shall be subjected to vibration through a frequency range of 10-55-10 Hz in a sweep period of 1 min with continuously varying frequencies. The vibration shall be applied for not less than 1 h in the directions of each of the 3 major axes of the light.

The transceiver after vibration test shall meet the requirements of visual examination and interoperability requirements with all components working at the end of the test.

### 6.8 Damp Heat Test

The transceiver should be tested according to IS 9000 (Part 5/Sec 2). The test is carried out at +25 to +55° C, humidity 95 percent. Six cycles (each test cycle of 24 h) should be run with the system in off condition. Interoperability test will be carried out with power in 'On condition' at start of 2nd, 4th and 6th cycle.

The system after the test shall meet the requirements of interoperability tests as per with all components working at the end of the test.

### 6.9 Ingress Test

The ingress test shall be carried out in accordance with IS/IEC 60947-1 in conjunction with IS/IEC 60529 : 2001 for IP 65 compliance for external and IP55 for internal DUT.

The system shall meet the requirements of interoperability tests and the requirements of IP compliance.

### 6.10 Corrosion Resistance Test

The system should be tested according to **4.8** of IS 10250 for 96 h.

The system shall meet the requirements of interoperability tests after the test with all components working at the end of the test.

### 6.11 High Voltage Test

The transceiver powered by external power shall operate for 60 min at 110 percent of the rated voltage without affecting the service life or function.

Transceiver shall meet the requirements of interoperability tests, after the high voltage test.

### 6.12 Operating Temperature Test

The transceiver shall be placed in cyclic chamber and subjected to operating temperature test as per specifications mentioned below:

| *Sl No.* | *Parameters* | *Specifications* |
|---|---|---|
| i) | Temperature | +55°C and –20°C |
| ii) | Duration | 16 h at each temperature |
| iii) | No. of cycles | 1 |

Transceiver shall meet the requirements of Interoperability tests, after the operating temperature test.

NOTE — The operating temperature test shall be in accordance with IS 9000 (Part 2) and IS 9000 (Part 3).

### 6.13 Storage Temperature Test

The system shall be placed in cyclic chamber and subjected to storage temperature test as per specifications mentioned below:

| *Sl No.* | *Parameters* | *Specifications* |
|---|---|---|
| i) | Temperature | +85°C and –40°C |
| ii) | Duration | 16 h at each temperature |
| iii) | No. of cycles | 1 |

Transceiver shall meet the requirements of Interoperability tests, after the storage temperature test.

NOTE — The storage temperature test shall be in accordance with IS 9000 (Part 2) and IS 9000 (Part 3).

### 6.14 Acceptance Tests for Transceivers

The following shall constitute acceptance tests for transceivers after every one year or 10 000 samples, whichever is achieved earlier:

a) Visual examination (*see* **6.2**),
b) Measurement of dimensions, and
c) Interoperability tests (*see* **6.3**).

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Amendments are issued to standards as the need arises on the basis of comments. Standards are also reviewed periodically; a standard along with amendments is reaffirmed when such review indicates that no changes are needed; if the review indicates that changes are needed, it is taken up for revision. Users of Indian Standards should ascertain that they are in possession of the latest amendments or edition by referring to the latest issue of 'BIS Catalogue' and 'Standards : Monthly Additions'.

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### Amendments Issued Since Publication

| Amend No. | Date of Issue | Text Affected |
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